

## **Flash Flood Climatology of New Mexico**

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**Introduction:** The second greatest weather hazard in New Mexico (lightning being the first) is flash flooding. As of this writing, New Mexico ranks 10<sup>th</sup> in the nation in flash flood deaths per capita, using statistics based on *Storm Data* (1959-2000).

New Mexico's flash flood problem stems from a number of factors. During the summer (June through August period), thunderstorm frequency is among the highest in the nation. Favored areas of the state have frequencies to rival central Florida, the thunderstorm capitol of the county. More abundant moisture during the summer can lead to excessive rainfall rates, with large volume runoffs when flows are enhanced by the terrain.

A low population density creates problems in documenting, reporting, and warning for flash flood events. New Mexico's population density is roughly one sixth the national average, and there are a number of counties with fewer than five people per square mile, less than one tenth the national average.

Communication issues contribute to a diminished capability to document, report and warn for flash floods. For one thing, NOAA Weather Radio, the "voice" of the National Weather Service (NWS), only covers about 50 percent of the land area of the state. The tone alert capability is far less than that, covering less than 15 percent of the state. In spite of these low numbers, the NOAA Weather Radio audio signal can reach about 70 percent of the population, due to the fact 40 percent of the state's population lives within listening distance of the transmitter that is located in Albuquerque.

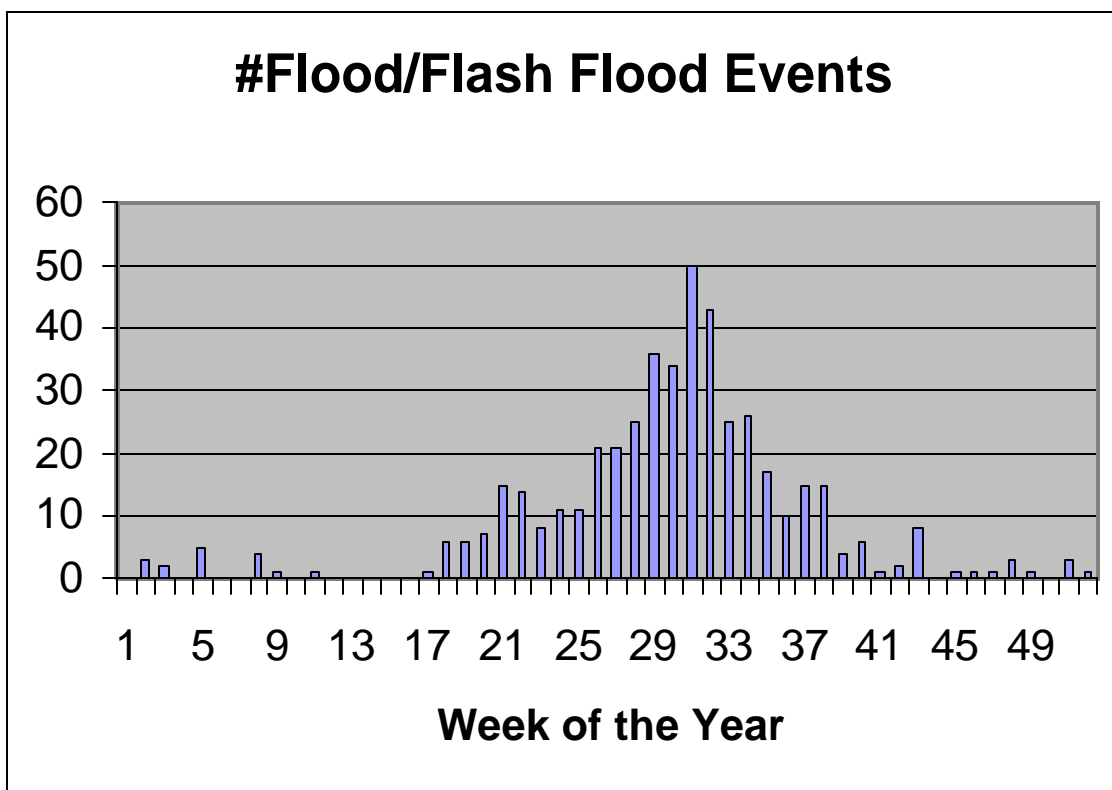
Another difficulty with flash flooding in New Mexico has to do with technological and human capabilities. Thunderstorms that impact humans are not necessarily the thunderstorms that have the greatest meteorological significance. Thunderstorms that produce the greatest signal return to weather radars are not necessarily the same storms that cause injuries or loss of life. For example, someone can be killed by a relatively-weak thunderstorm that only produces one bolt of lightning. A "garden variety" thunderstorm that just happens to drop enough rain in the right location to cause excessive water flow across a low-water crossing in a road may contribute to the death of those who drive into the flowing water over the road. That is, a flash flood is not purely a meteorological event. The potential for human impact of that storm may be far greater than a larger, severe storms with large hail striking a remote area with no humans around.

Another difficulty with flash flooding has to do with human limitations of meteorologists using the latest technology. On a typical July or August afternoon in New Mexico, there may be 50 to 150 thunderstorms in progress at any one time. A meteorologist cannot monitor each storm's life cycle, and radar algorithms are not smart enough and haven't evolved enough to determine potential for human impact.

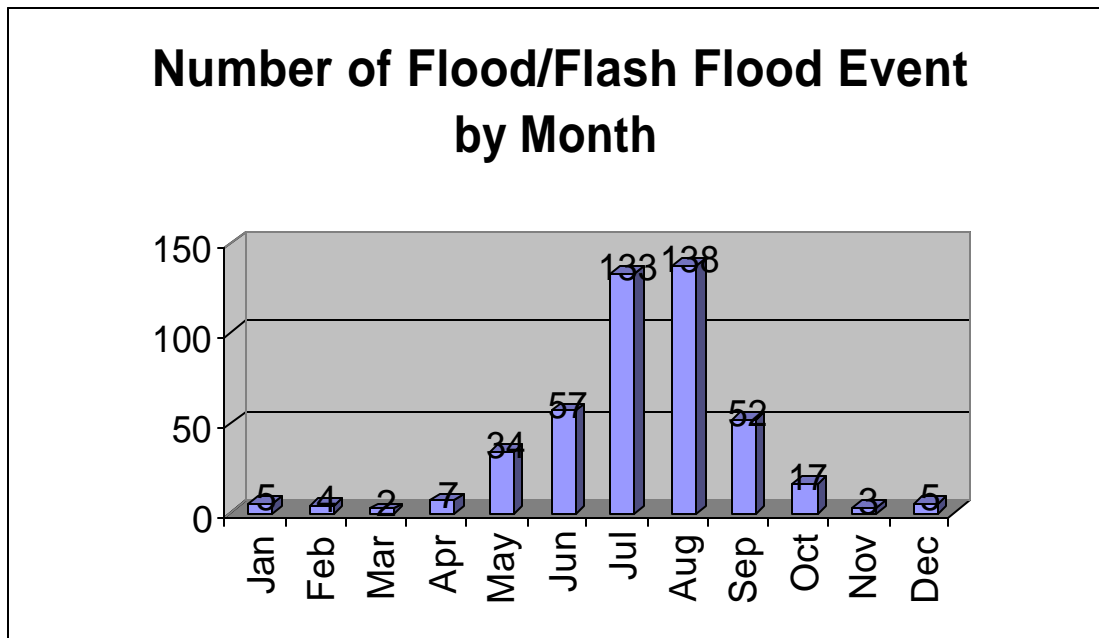
**Methodology and Caveats:** The publication, *Storm Data* was used to determine the number of flash flood events in New Mexico for the period 1959-2000. First, the number

of total flash flood events was determined for seven-day periods, beginning January 1. The next “week” was January 8, then January 15 and so on. The last week, which began December 29, overlapped with the first week. This did not create an issue as there were no flash floods for the period December 29 through January 7 anyway.

The number of events per “week” were plotted for the entire year. This is shown in figure 1 and will be discussed in the section below. Second, events were totaled for each month. These are shown in figure 2 and will be discussed in the section below. Third, the number of flash floods for each month were plotted on a county map of New Mexico, indicating the favored areas for specific months. To show the emphasis of seasons, some of the results were combined into two or more months. The July and August peak is shown in figures for each month separately, as well as combined.



*Figure 1 (number of flash flood events for each week of the year)*



*Figure 2 (number of flash floods per month)*

Now for the caveats. It's very likely that a large number of flash floods that occurred in New Mexico from 1959 through 2000 were not documented. One only has to glance at the *Storm Data* publication to see the substantial increase in volume since the late 1980s. Although there are still flash flood events that go unreported in New Mexico, far more events are reported now than in the years prior to the late 1980s. There are a few reasons for this. One is that the NWS made very little effort to document events prior to the late 1980s. Warnings were simply issued if the meteorologists had substantial reason to think a warning was needed. There was some effort to verify warnings, but not a lot. If it weren't for occasional floods and flash floods associated with rapid melting of snow, it's likely we wouldn't have any flash floods reported for Mora County. Even though the Southwest monsoon is in full swing from mid-July through August, Luna county has only reported one flash flood during that time period since 1959.

One can look at data from the 1960s and 1970s and find years in which very few flash floods were reported. It's extremely unlikely we had years during that time period with virtually no flash floods. It's far more likely there wasn't much emphasis on retrieving information, and also that many events occurred in remote areas with no one there to report them. Even in the late 1980s, the Albuquerque forecast office received "next day" calls from communities and state park personnel after events had moved huge boulders in remote areas overnight. The August, 1989 flash flood in Villanueva (along the Pecos River) was produced by approximately six inches of rain in a one and one half hour period during a time when there was no weather radar, and satellite imagery was unavailable.

Another major contributor to the lack of documentation in earlier years is that the forecast office in Albuquerque had no weather radar until 1994. Methodology to detect events was crude, to say the least. Meteorologists utilized the FAA ARTCC radars, satellite data, and gathered information by phone from affected areas (if the storm was in a populated area).

Consequently, it is certain far more flash floods occur in New Mexico than we know. In spite of that, the relative numbers are likely consistent with the peak flash flood occurrences in the state.

One other difficulty with a study such as this is that the distinguishing “line” between what constitutes a flash flood is unclear. Just how much water running through urban streets does it take to have a flash flood, as opposed to the nuisance of a summer afternoon shower? Technically, water flowing through a normally dry arroyo is defined as a flash flood, but how much water are we talking about? There have certainly been cases where only half a foot of water flowing through a normally dry arroyo was hardly noticed. Yet, there have been cases where kids playing in the arroyo were swept away and drowned because half a foot of water knocked them off balance and took them quickly into deepening flow.

Differentiating between a flash flood and a flood is not so simple either. Since the damming projects of the middle 1900s, most floods in New Mexico are now flash floods, but not all of them. This will be discussed more in the results section.

**Discussion of Results:** Most weather watchers and meteorologists in New Mexico would associate flash flooding with the so-called summer monsoon season, and they would be right.

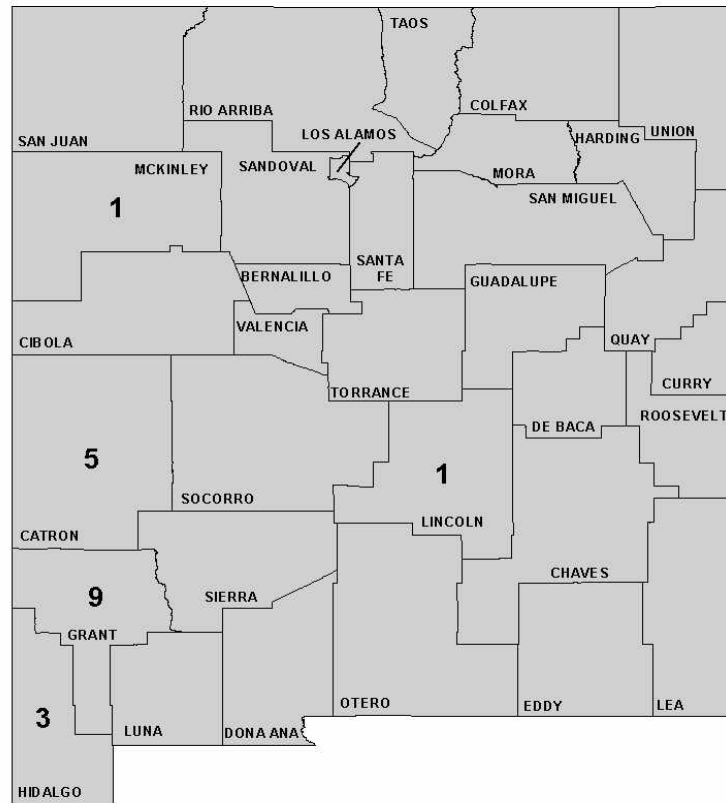
Approximately 60 percent of all documented flash floods in New Mexico have occurred during the months of July and August. Whatever you want to call it, the feature that manifests as a northward extension or series of bursts from the Mexican monsoon plays a large role in the flash flood climatology of New Mexico. For argument sake, I will refer to this feature as the Southwest monsoon for the remainder of this paper.

The Southwest monsoon actually does have a recognizable signal in New Mexico, especially the southwest corner of the state. Most of what happens during summer elsewhere in the state is a

hodgepodge of the Southwest monsoon, along with perturbations in the westerlies that can affect the state dynamically, as well as allow influxes of moisture from the Gulf of Mexico or other sources. In any case, the end result is that once enough moisture is injected into an environment that is unstable (as our atmosphere typically is throughout the warm season), thunderstorms will erupt.

The following is a season by season discussion of New Mexico’s flash flood occurrences.

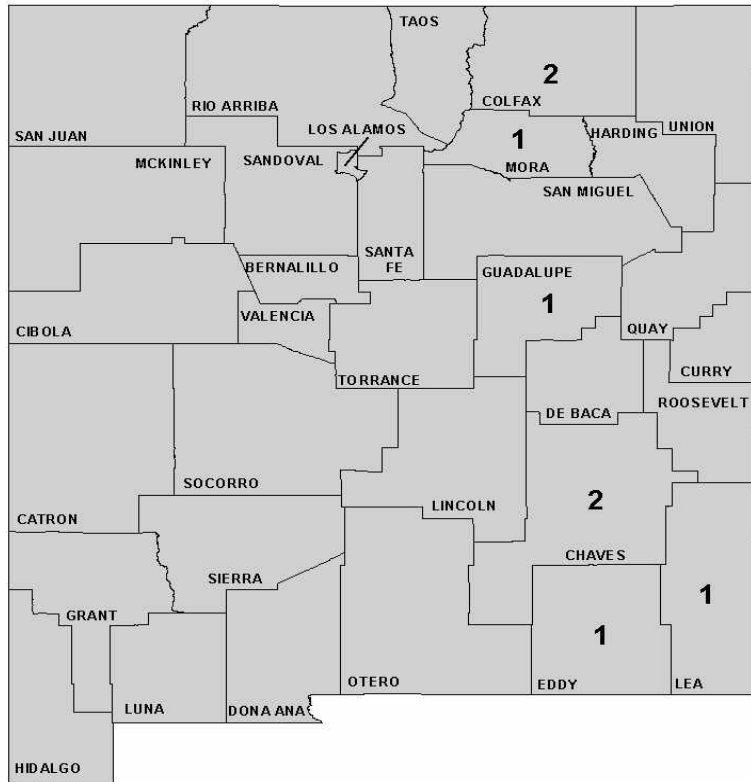
**Winter:** Winter events are the most difficult to classify as flash floods versus floods. Most winter events are the result of unseasonably-high level rain on top of a snow pack. Excessive runoff allows the combined release of the water in the snow pack along with the rain. These can be “flashy” events lasting less than a day, or they can evolve into longer-term flooding of day or event a couple of weeks. Before writing this paper, I would have guessed December was the prime month for this to happen. However, data suggests little variation in likelihood from late November through February. The most devastating events seem to have occurred in December, though. All occurrences during this time frame have been over the southwest (Gila Region) portion of the state (fig 3).



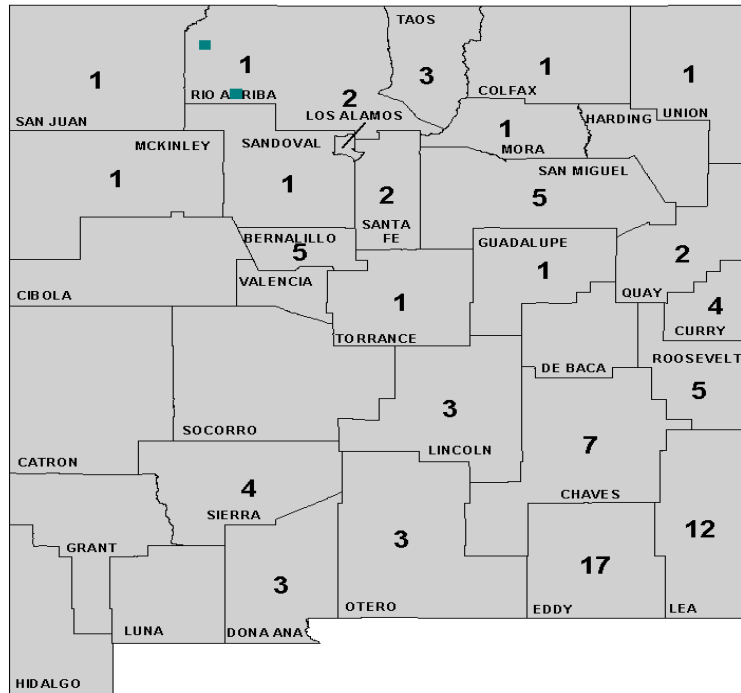
*Figure 3 (Number of flash floods reported Dec-Mar 1959-2000)*

**Spring:** Most spring events are of two varieties. (A) One is very similar to the winter events, but this time the rain falls over a “ripe,” mature, snow pack. Consequently, this type of event originates in or near the mountains. Similar to the winter events, what may begin as a flash flood frequently evolves into a flood event. Those events actually categorized as “flood” events outnumber the “flash flood” events of this type. The favored time of year for these events is from late April into June. (B) The second type of spring event occurs in the Eastern Plains and is associated with the passage of cold fronts, abundant moisture from the Gulf of Mexico, and upslope conditions (usually). Favored time for these events is quite distinct, from the last week in April through June. Peak occurrences have been the last two weeks of May, and the last week of June. While all of the Eastern Plains is subject to this type event, the greatest frequencies have been in the

far southeast, in Eddy and Lea counties. Figures 4 and 5 show the number of reported flash floods for April, and May-June, respectively.



*Figure 4 (Number of flash floods reported April 1959-2000)*



*Figure 5 (Number of flash floods reported May-June 1959-2000)*

**Summer:** After a relative maximum of flash flood events from around May 20 through 31, there has been a bit of a lull in activity through the first three weeks of June (fig 1). The spring type “B” events still occur in the Eastern Plains, but are more spread across the Eastern Plains than in May, when they are mainly confined to the far southeast. June is typically extremely dry in the southwest part of the state, with no flash flood events reported at all for six counties.

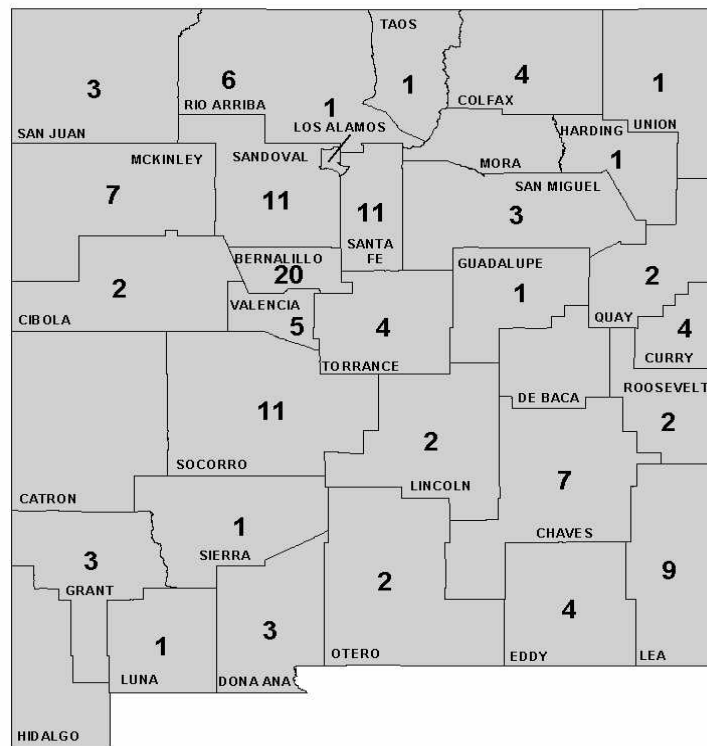
From figure 1, you can see that the number of flash flood events nearly doubles (11 to 21) from the “week” of June 17 to the week of June 24, but then doesn’t change dramatically for the next two weeks. The number of events was also 21 for the week beginning July 1, and increased slightly to 25 for the week beginning July 8. There is a more dramatic jump (to 36) for the week beginning July 15. The peak of the season (50 events) is for the week of July 29 through August 4, while the following week drops to 43 events.

The weeks of August 12 and 19 show a fairly dramatic drop to 25 and 26 events, respectively. The drop continues the following week, with 17 events the week of August 26. However, after a brief lull (the week of September 2 has only 10 events), there were 15 events for the weeks of September 9 and 16. After that, the week of September 23 falls to a mere four events.

Of course, as forecasters and weather watchers in New Mexico have known for a long time, there is a major shift in location of activity from June to July. Although activity doesn’t really diminish much in the Eastern Plains, there is a tremendous increase in the

activity over the western half of New Mexico (fig 6). With 40 percent of the state's population living in the Albuquerque metro area, it's no surprise that Bernalillo county easily tops the list for the number of events in July and August (fig 7). Considering the stronger monsoon signal in the southwest counties, the low number of July and August events reflects the remoteness of the Gila Region. The precipitation distribution at Rodeo (extreme western Hidalgo county) reflects the affect of the Southwest monsoon. Rodeo receives only 3 percent of its annual precipitation in June, but a whopping 25 percent in July. Much farther north, flash flood events increased from 3 to 10 in San Juan county from July to August, indicating the northward progression of the affects of the Southwest monsoon. As forecasters in Albuquerque have likely known (or suspected) for a long time, the main affect of the Southwest monsoon over northwest New Mexico is felt in August.

Another summer (especially late) event type is due to movement of hurricane remnants and tropical storms into New Mexico from both the Gulf of Mexico and the Pacific Ocean. Like the winter events, these can begin as flash floods, or a number of flash floods, and turn into longer-term floods. Peak time of occurrence spans two seasons, with the favored time extending from the middle of August through the middle of October.



*Figure 6 (Number of flash floods reported July 1959-2000)*

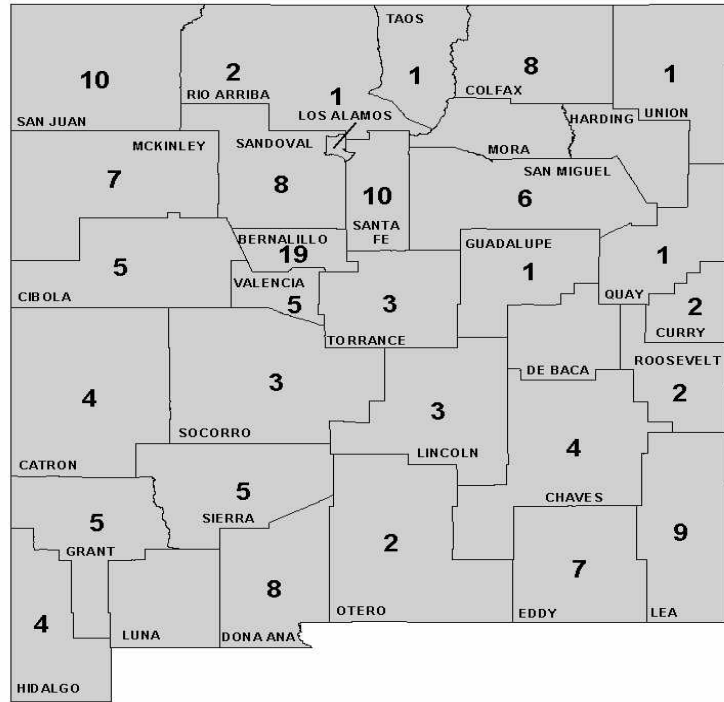


Figure 7 (Number of flash floods reported August 1959-2000)

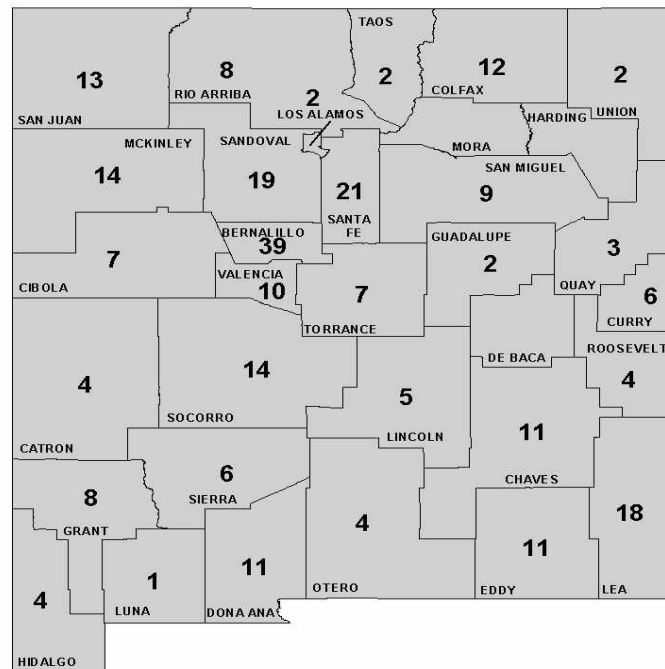
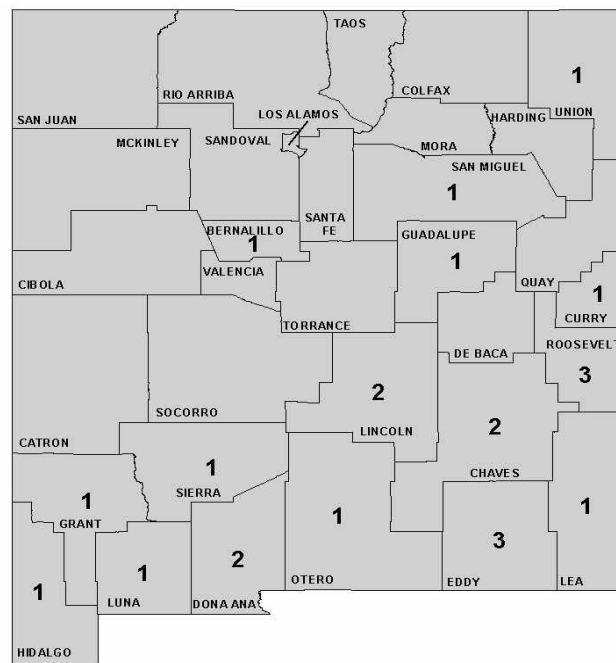


Figure 8 (Number of flash floods Jul-Aug 1959-2000)

**Autumn:** While the monsoon season generally dies a quick death over northern New Mexico (especially northwest) in early September, it tends to linger through mid or even late September in the south. Eddy and Lea counties had nearly as many events in September as they did in July and August. In fact, the far southeast portion of New Mexico has a relatively smooth distribution of flash flood events from May through September (not too surprisingly similar to their thunderstorm distribution). Although the highest frequency of September events was in the far Southeast Plains (fig 9), there was another relative maximum over the northwest and north-central counties. These events were mainly associated with the first good shot of westerlies in early September interacting with high-levels of residual moisture remaining from the Southwest monsoon, or from similar events in the westerlies interacting with the last northward surge of the season of deep moisture from the Southwest monsoon. Most events in the extreme southeast were also associated with remnants of tropical systems. By October, the northwest is virtually flash flood free. There weren't many events during October, but most of them were in the southeast. These events tended to be combinations of tropical remnants interacting with cold fronts moving southward through the Eastern Plains.



*Figure 9 (Number of flash floods reported Oct-Nov 1959-2000)*